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DETERMINING POWER USING A STOPWATCH AND CUP

<u>Aims of study</u>

Part of the work that the bladder performs during voiding is used to accelerate urinary flow. Because maximum urinary flow rate (Qmax) reflects the kinetic energy of urine during voiding, Qmax/flow time (T) is thought to reflect the mean power of inertia of the urine. However, if mean urinary flow rate (Qave)/T can be used instead of Qmax/T, power may be determined without using any special equipment. In this study, we investigated whether the power of inertia of urine in the urethra during voiding can be estimated using voided volume (VV) and T.

<u>Materials and methods</u>

Uroflowmetry curves from 272 cases were approximated using the voiding model (1). Work used for inertia of urine was calculated by the integral of PdV using pressure (P) and change in VV (dV). Numerical calculations were performed. Power was calculated by dividing work by T. Qave was obtained from VV/T, and Qave/T from VV/Tˆ2 (volume time index; VTI). Qmax, T and VV values were obtained from the results of calculations of simulations**.**

<u>Results</u>

In the voiding model, work was proportional to 0.5*L*Qmaxˆ2 (L is the inertia coefficient), but it was proportional to 0.479*L*Qmaxˆ2 (r=0.998) by statistical calculation. Power had a good correlation with Qmax/T and VTI, and it was
Power=0.586*(L*Qmax/T)ˆ1.25, r=0.971, and
Power=1.05*(L*VTI)ˆ1.22, r=0.965, respectively.
By standardizing L=1, we were able to compare power using VTI. Because another study had shown that Qmax/T=1.45*VTI + 0.0482 and Qmax/T of 0.78 or over was normal (2), VTI of 0.5 or over was regarded as normal from the regression line. As a result, mean VTI was 0.949 (n=63) for normal males and 1.44 (n=9) for normal females, while it was 0.323 (n=199) for BPH cases.

<u>Interpretation of results</u>

As power better reflects the force of urine discharge than work, the change in Qmax/T is thought to reflect the change in voiding conditions better than the change in Qmax. This can also be assumed from the fact that the unit of Qmax/T is ml/sˆ2 and that it indicates the degree of acceleration of flow. When L=1 was standardized, we found that VTI reflected power. Although Qmax/T similarly reflects power, a uroflowmeter is necessary to determine Qmax, while Qave does not require one. As Qmax and Qave also had a good correlation statistically, our results were as predicted. VTI was low at 0.323 for the BPH group, which indicated a decreased power compared to those of normal males (p<0.0001) and females(p=0.0002). From the results of the other 161 cases, VTI=0.48 was the cutoff point for lower urinary tract obstruction from the relation of VTI and urethral loss coefficient (resistance) (3). This was not inconsistent with the normal VTI lower limit of 0.5. It is possible to use VTI not only as power but as the index of urethral resistance (3). The decrease in VTI indicates the increase in urethral resistance as well as the decrease in the power of inertia in the urethra. To obtain VTI, VV can be measured by a cup and T using a stopwatch. If power can be estimated without using a uroflowmeter, voiding conditions can be easily estimated by persons other than a urologist. In addition, if T can be recorded in Frequency volume chart daily, VTI can be easily calculated. Therefore, VTI may be a useful index despite its simplicity requiring no particular equipment.

<u>Concluding message</u>

We were able to determine the power of inertia during voiding from T and VV using only a stopwatch and cup.

<u>References</u>

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